NOAA's NATIONAL CLIMATIC DATA CENTER

# NCDC

## Protecting the Past...Revealing the Future

Annual Report

2004

# Contents



**The mission of the NCDC** is to

and accessible source of quality

data and information services

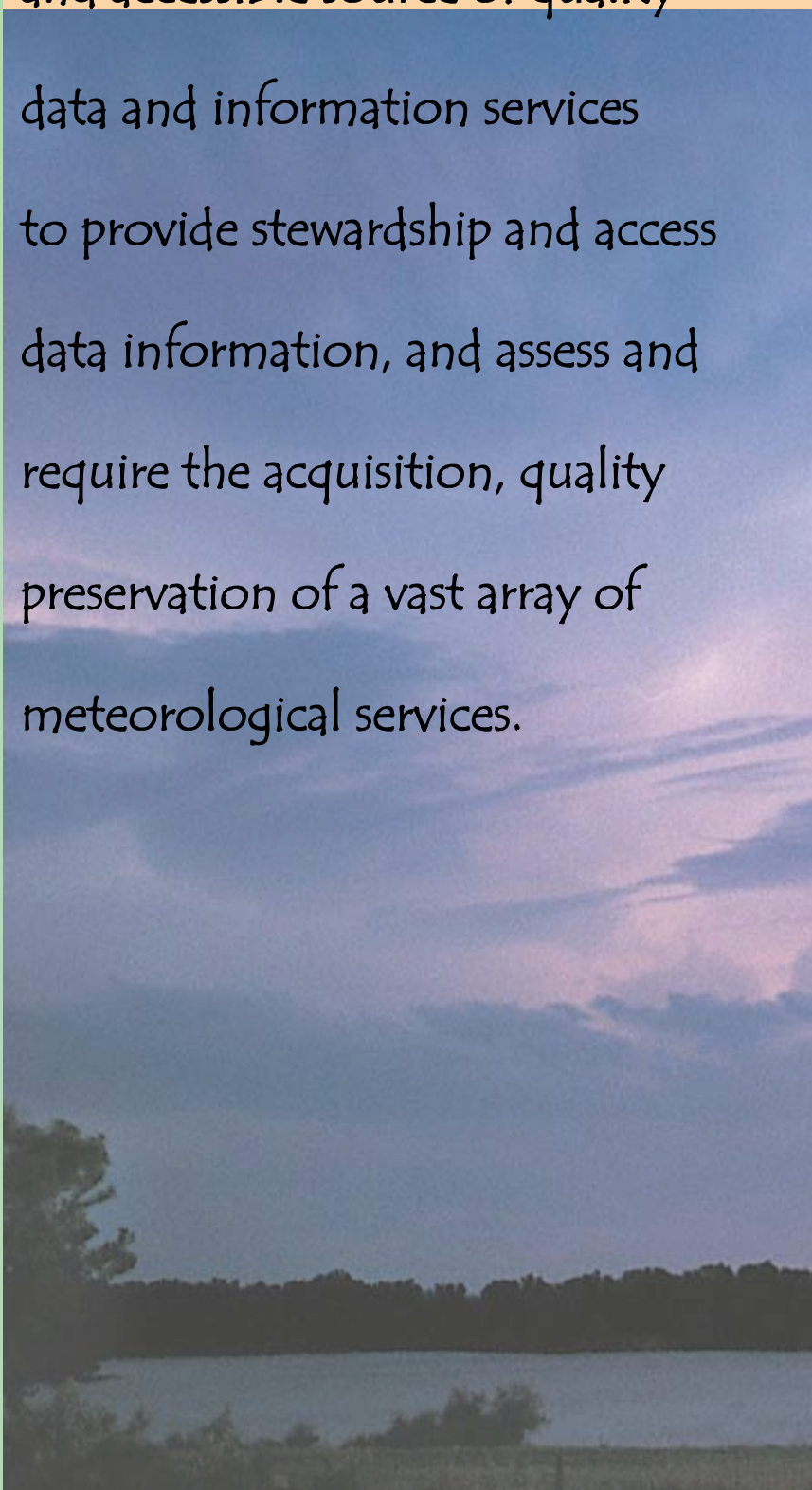
to provide stewardship and access

data information, and assess and

require the acquisition, quality

preservation of a vast array of

meteorological services.



NCDC

be the most comprehensive

climate and weather related

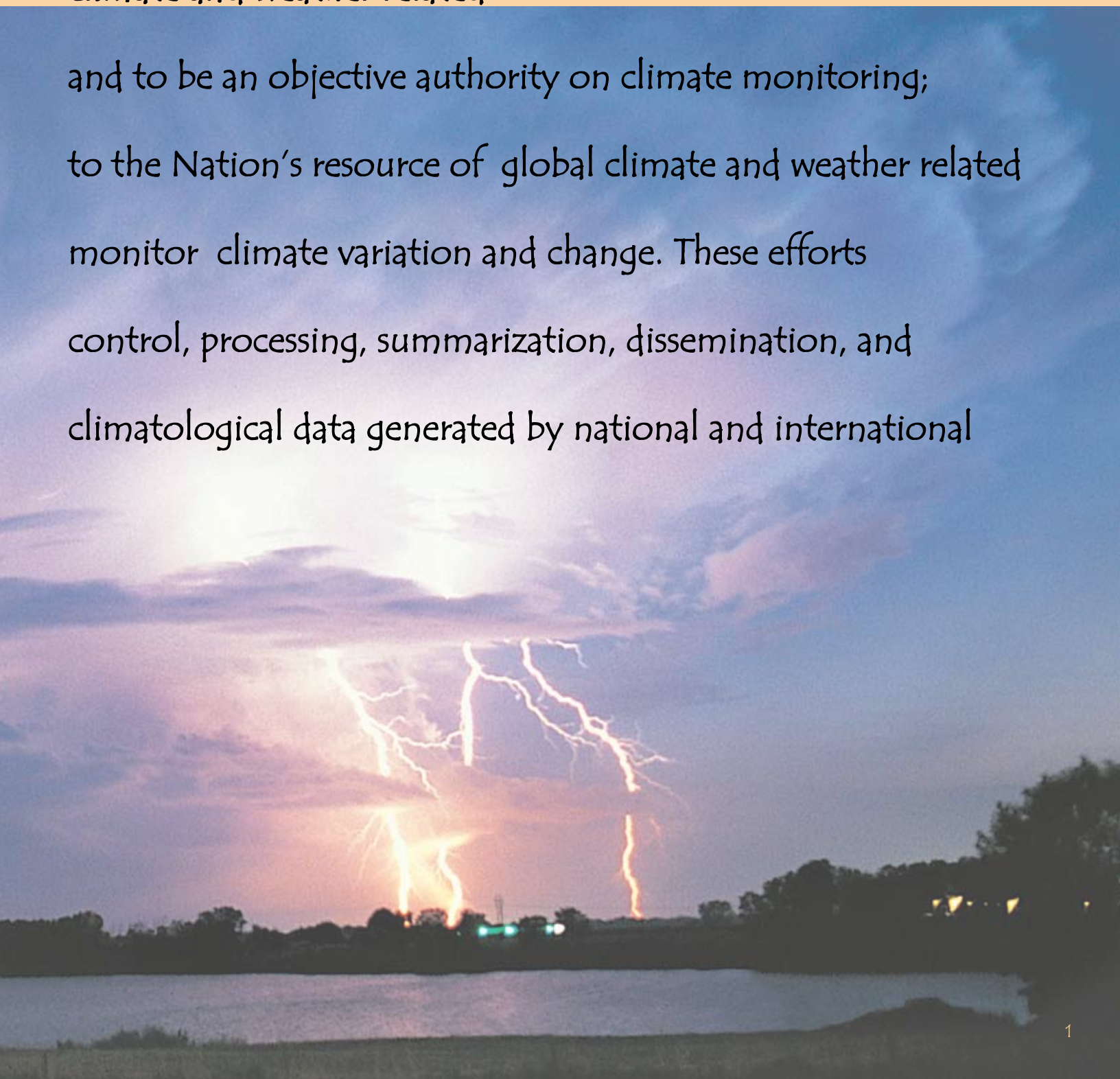
and to be an objective authority on climate monitoring;

to the Nation's resource of global climate and weather related

monitor climate variation and change. These efforts

control, processing, summarization, dissemination, and

climatological data generated by national and international



# LETTER FROM THE DIRECTOR

This report is to inform the reader on the distinctive role of the National Climatic Data Center (NCDC). Working with our partners, both internal and external to NOAA, the NCDC provided our users exciting, new climate data and information. Sustaining our track record of excellence is only possible due to the hard work and dedication of our employees. Achievements include:

- Remote Sensing and Applications Division's collaboration with NOAA Data Centers furthered the development of the Comprehensive Large Array-data Stewardship System (page 3);
- NESDIS e-Government System (NeS) implemented at the three NOAA Data Centers (page 3);
- NOAA's Climate Database Modernization Program projects reached all-time high (page 4);
- Climate monitoring improved (page 6);
- Inclusion of performance monitoring into observational networks developed (page 8);
- U.S. Climate Reference Network (CRN) installed 24 new stations in 2004 (page 9);
- NOAA Operational Model Archive and Distribution System (NOMADS) grew (page 10);
- New NCDC homepage set record for data delivered on-line (page 11);
- U.S. Global Climate Observing System (GCOS) Program Office continued support of international observing activities (page 12)
- New Climate and Weather Impacts on Society and the Environment (CWISE) partnership formed between NCDC and academic institutions (page 13);
- New organizational infrastructure developed between NCDC and Regional Climate Centers (RCC) (page 14);
- NOAA's Paleoclimate Program expanded data archive (page 15);
- Support for local community continued, including signature SCHOLARS program (page 16);

NCDC achieved all performance measures, often exceeding them by a wide margin. We take pride in offering the best products and services for our broad-base of users and in playing a prominent role in public safety, protection of property, sustainable development, environmental awareness, and homeland security. Given our motto of "Protecting the Past, Revealing the Future," we recognize our responsibility as the world's most comprehensive authority for weather and climate information. As a leader in observing how climate varies and changes on all time scales, and its impact on the economy and society, we continue to develop partnerships with the private sector, academia, and other government agencies.

We have strived to continually improve our weather and climate services to our customers, by increasing the volume and availability of the archived data in near-real time. In addition, our on-line capabilities have been strengthened, allowing users easier search and retrieval of desired data, which increases customer satisfaction. We have also issued numerous press releases detailing the state of the climate and important trends such as the severe drought of 2004 that was closely monitored for the Western states. NOAA's six Regional Climate Centers (RCC) and the American Association of State Climatologists (AASC) have been an important complement to much of this effort.

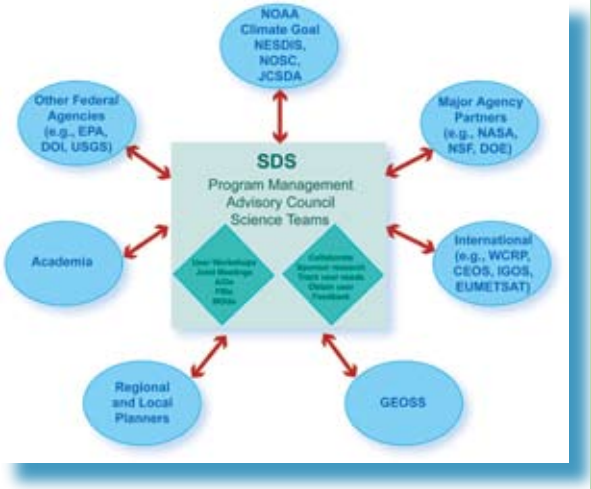
Beyond our traditional weather and climate services, our information is used to support national and global disaster mitigation and relief efforts. In 2004, NCDC played a principal role in NOAA's Climate Services Program. We will continue to expand these efforts, in collaboration with other NOAA organizations.

The items in this report could not be realized without the great effort put forth by the Center's talented and committed personnel. I extend my sincere gratitude and recognition to our personnel and partners for their effort. NCDC upholds the challenge to discover new climate data resources and applications. We look forward to working with the NOAA team in providing the best climate information service, to the people of our Nation and beyond.

Thomas R. Karl

# REMOTE SENSING AND APPLICATIONS DIVISION

NOAA manages the Nation's civil operational environmental satellite system. NOAA also has statutory responsibility for long-term archiving of the Nation's environmental data. Increasingly, this responsibility is expanding to provide information on the health of the environment in real-time to both national and international users, and to respond to growing demands for stable long-term climatic data records (CDRs) derived from satellite observations. In order to meet these needs, NOAA must provide a framework to ensure that satellite climate data are processed, archived, and distributed to users in a manner that is scientifically defensible for monitoring, diagnosing, understanding, predicting, modeling, and assessing climate variation and change.



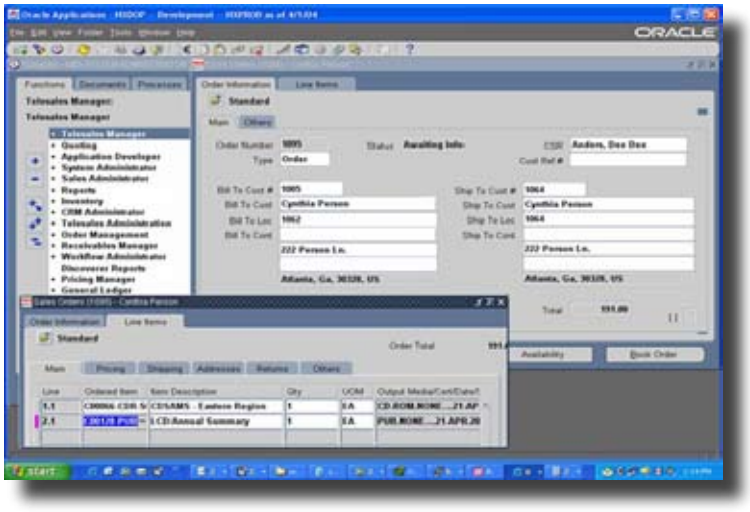

In response to these data product and service challenges, NCDC, in collaboration with the other NOAA National Data Centers, has placed renewed emphasis on their archive and access systems for large volumes satellite data sets (the Comprehensive Large-Array data Stewardship System or CLASS) and has created a new program element to specifically address the need for asserting national leadership for satellite-based CDR generation called Scientific Data Stewardship (SDS).

The new emphasis on climate products and services from satellite and in situ data within NOAA's mission requires an increased focus on partnerships. This is particularly important in the development, analysis, reanalysis and research of CDRs. Creating a program to develop, produce, archive and disseminate CDRs will require a large investment of resources and expertise. NOAA cannot do this alone. NOAA's SDS implementation plan to create CDRs will involve establishing a wide variety of partnerships as illustrated schematically in the above Figure. NOAA's SDS Program will officially begin in FY 2006.

# CLIMATE SERVICES

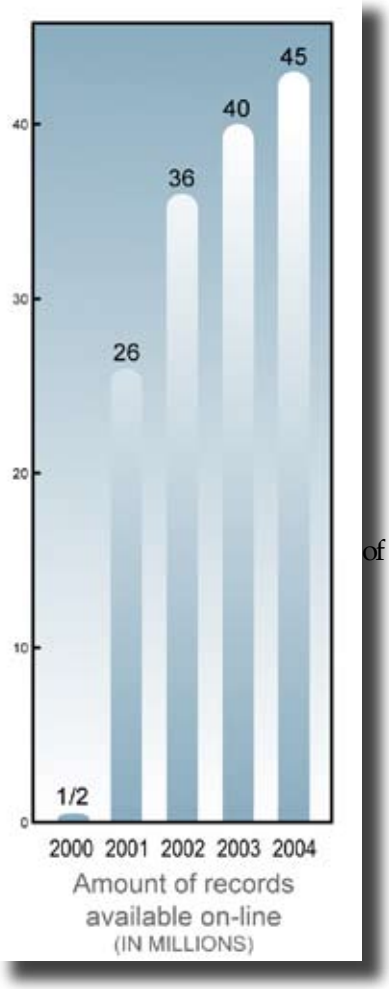
**NESDIS e-Government System (NeS) Implemented**

The NESDIS e-Government System has been successfully implemented at the three NOAA Data Centers, meeting milestones established two years ago, with full operational mode beginning on October 1, 2004. NCDC, the National Oceanographic Data Center (NODC), and the National Geophysical Data Center (NGDC) are now entering all off-line orders into NeS. These are orders which are paid for by data center customers for delivery on various media, such as CDROM. This has been an exceptional achievement thanks to the hard work and dedicated efforts of the NeS team. NeS will serve as the e-government system for all paid orders for the CLASS and the National Virtual Data System (NVDS). NeS will be expanded in the future to include order processing for the Regional Climate Centers (RCC).



# CLIMATE DATABASE

**The Climate Database Modernization Program's** main mission is to image and key historic climate records. Original paper observation forms are imaged and indexed, and placed into an online database, which is available electronically via the Internet. Then the data on these images are keyed by CDMP contractors, which put the data in an accessible digital format. These activities not only benefit NOAA, by modernizing and preserving the records digitally, but more importantly the data are available and easily accessible for hundreds of thousands of customers in government, commerce, industry, science, education, engineering, and national defense.




Imaged records are made available online through the WSSRD® system (Web Search Store Retrieve Display) operated by CDMP contractor Information Manufacturing Corporation. The number of images online has grown from just one-half million in 2000 to over forty-five million at the end of 2004, equating to nearly 5 Terabytes (TB) of records. The keying of the historical data records has extended the digital database from 1948 back to the establishment of some 160 airport stations, and the first observations taken in support of aviation operations. The period of record is being extended back into the 1800s by keying Weather Bureau city office and Army Signal Service records.

In November 2004 CDMP held its annual Data Access Workshop as a forum for information and experience exchange between the various NOAA task leaders. The workshop held at NCDC allows for the presentation of new and continuing proposals by NOAA agencies for the upcoming year's program. Over 30 proposals were submitted for FY 2005 support. In 2004, CDMP supported 20 separate tasks across all five NOAA operational Line Offices, as well as 21 tasks for NCDC as indicated in the pie graph on page 5.

## Some of the climate data sources made available aby CDMP

- Early 20th century U.S. surface and upper-air observations
- 19th century U.S. Signal Service surface observations
- Upper-air data from six African nations
- Historic Daily Weather maps from 1871 to the present
- Iraqi upper-air data

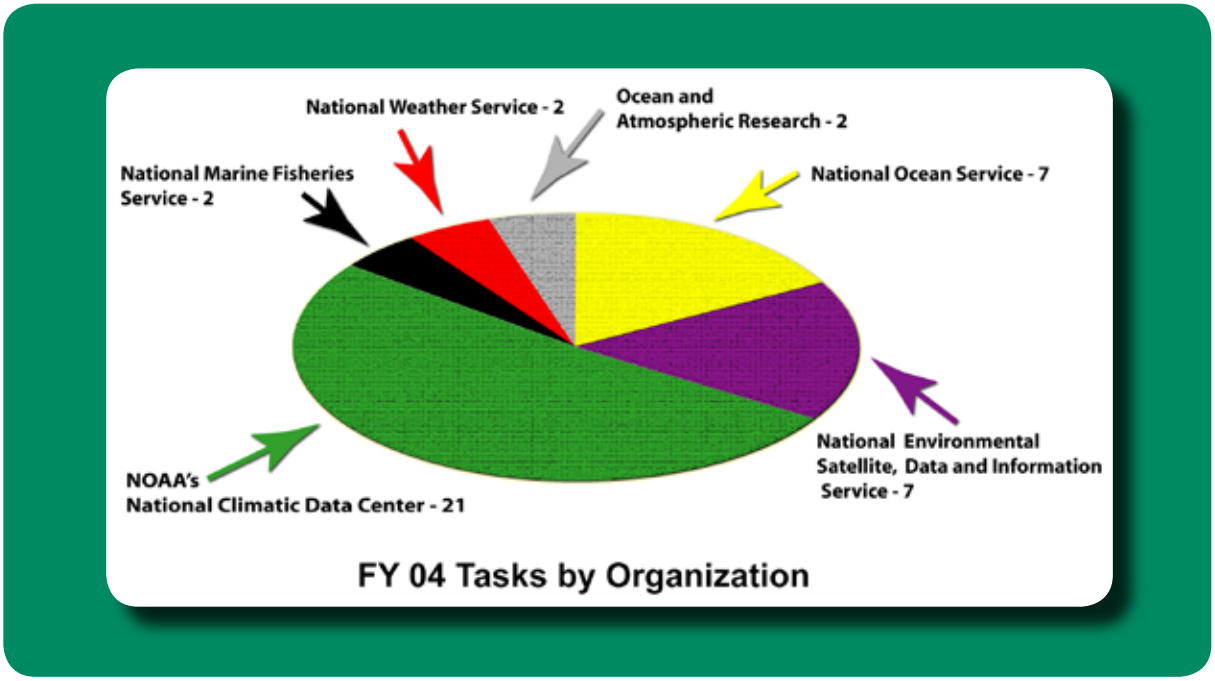
# MODERNIZATION PROGRAM (CDMP)

**Climate and environmental data projects that have been undertaken by CDMP include:**

- Digitization of the Army Signal Service Records (Forts), a multi-year project to extend the climate database back to the early 1800s. Over 30 of the total 160 stations have been keyed as of December 2004
- Imaging and keying of early 20th century U.S. surface and upper air observations
- Keying of upper air observations, provided by six African nations using digital camera technology
- Imaging of historical U.S. Daily Weather Maps. The series is now available via the Internet from 1871 to the present
- Hurricane reconnaissance data preserved on microfilm are being imaged, and data on movie film are being converted to streaming video
- Keying of Canadian marine observations, for addition to the international marine database


- Nautical charts are being imaged, geo-referenced, and the shorelines vectorized
- Defense Meteorological Satellite Program film segments are being scanned
- Keying of Ionospheric records
- Imaging of Arctic Sea Ice charts

See the CDMP web page at: [www.ncdc.noaa.gov/oa/climate/cdmp.html](www.ncdc.noaa.gov/oa/climate/cdmp.html) for more information on the program.




**Total number of NOAA CDMP projects reached an all-time high (40 plus in 2004)**

## *2004 Warm and Wet Year for the U.S.; Global Temperature 4th warmest on record*


The climate of 2004 was warmer than average across much of the western half of the Nation with near average temperatures in the Southeast and Northeast. The South and East were much wetter than average with the West having a drier-than-average start to 2004, but becoming relatively wetter in the latter half of the year. The average temperature for the contiguous U.S. was 53.5° F (11.9° C), which is 0.7° F (0.4° C) above the long term mean and the 24th warmest year on record dating back to 1895. It was also the 6th wettest year on record for the Nation.

**Widespread warmth** was again the mark of the annual climate for the U.S., with only one state (Maine) averaging significantly below the long-term mean for the year. Spring and fall were especially warm seasons (4th and 12th warmest on record, respectively), but were separated by a relatively cool summer, ranking 9th coldest on record for the contiguous U.S. However, the West remained warm even in summer with Oregon and Washington both ranking in the top five warmest summers for their states while Alaska shattered previous summer warmth records (dating back to 1918) with an anomaly of 4.6° F (2.6° C) above the 1971-2000 mean. It was the 4th warmest year on record for Alaska.

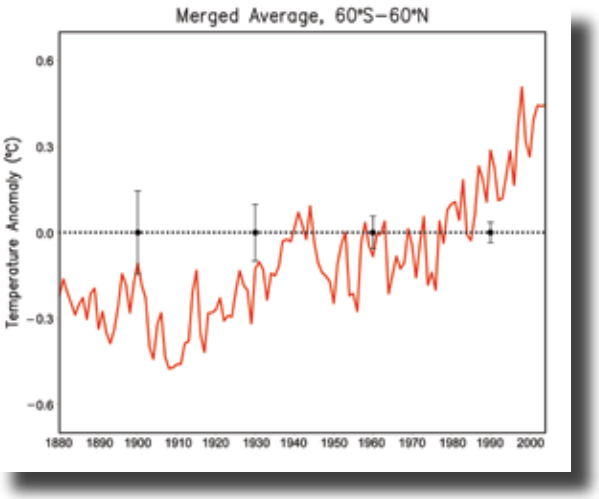
The year began with sharp contrasts in precipitation, with above average precipitation in the east and drier-than-normal conditions in the West. The lack of rain in the **western U.S. exacerbated multi-year drought** conditions, and above average warmth in the spring led to premature snow melt. Reservoirs failed to refill adequately in the spring and despite average or above-average rainfall later in the year, many reservoirs in the West remained well below normal levels at years' end. As much as 69% of the region from the Rockies westward were in moderate to extreme drought in March 2004, based on a widely used measure of drought, the Palmer Drought Index. By the end of December however, only around 10% of the West was in moderate to extreme drought. Although short-term improvement occurred during the fall and early winter, hydrologic drought remained across a large protion of the western U.S.

After a record wet year for parts of the eastern seaboard in 2003, much of the east was again wetter than average in 2004 as a wet summer was followed by **multiple landfalling hurricanes** in the early fall. Nine tropical systems affected the U.S. including six hurricanes, three of which were classified as major on the Saffir-Simpson Scale of hurricane intensity. Four of the six hurricanes struck Florida, making it the only state since 1886 to sustain the impact of four hurricanes in one season (Texas also had four hurricanes in 1886). Hurricane Charley in August was the strongest hurricane (category 4 at landfall) to strike the U.S. since Andrew in 1992 and caused an estimated $14 billion in damage. Hurricanes Frances, Ivan and Jeanne quickly followed Charley in September.

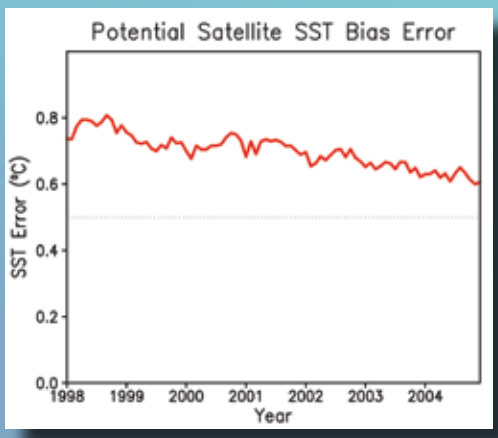
**Globally averaged temperatures** in 2004 were 4th warmest since 1880 (the beginning of reliable instrumental global records). Warmer years were 1998, 2002 and 2003. The 10 warmest years have all occurred since 1990, with nine of those occurring since 1995. Averaged over the year, land surface temperatures were anomalously warm throughout western North America, southern and western Asia and Europe. Boreal fall (September-November) as well as November were warmest on record for combined land and ocean surfaces. Other notable climate events and anomalies across the world in 2004 included an active tropical season in the Northwest Pacific, with Japan sustaining ten tropical cyclone landfalls, exceeding the previous record of six; below normal monsoon rainfall for India, especially in the Northwest part of the country; flooding in Northeastern India from monsoon rains in June-October; a rare hurricane in the South Atlantic in March; and an extensive and severe heat wave in Australia during February. A weak El Niño developed in the central and western Pacific during the latter half of 2004, though global impacts were largely absent at the end of 2004.

## Historic surface temperatures are an important indicator of climate change

An improved temperature analysis has been computed from 1880 to present. This analysis is determined by combining a surface land temperature analysis based on the Global Historic Climate Network and a sea surface temperature analysis based on the International Comprehensive Ocean-Atmosphere Data Set. The combined analysis is a spatially complete surface temperature analysis on a 5° spatial grid with error estimates. A time series of the annual average temperature between 60°S and 60°N is shown, as departures from a 1961-1990 climatological normal. The time series shows an overall increase with time, with a greater increase after 1970. Because the number of observations has increased with time, the temperature errors also decrease with time as indicated by error bars in the figure. These data are now available to users at the NCDC Global Climate at a Glance site: http://www.ncdc.noaa.gov/gcag/gcag.html.



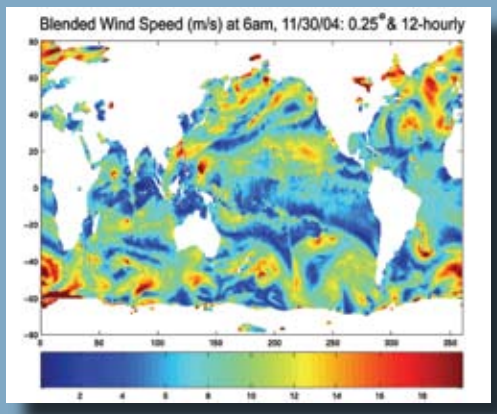

## Ocean Observations and Sea Surface Temperatures




Recent analyses of sea surface temperatures used in situ (ship and buoy) as well as satellite data. The satellite data provided high resolution coverage while the in situ data provided ground truth. Analyses used for climate purposes must have high accuracy. The in situ data have a critical role in the reduction of any satellite bias. The present in situ observing system has been examined and the results show the minimum number of in situ observatons required to correct any potential satellite bias to below 0.5° C. These results show that bias errors could be reduced below 0.5° C if there were at least two buoys in each 10° spatial grid square. Ship observations can be used to have seven ship observations to equal one buoy obseration. Monthly data densities of existing ship and buoy observations have residual potential satellite bias from 1988 to present. This result shows that the error is decreasing with increasing time. This is due to the deployment of additional buoys. This evaluation is now operationally produced every season with spatial maps showing where new buoys are needed. NOAA's Atlantic Oceanographic and Meteorological Laboratory is now using these results to guide their buoy deployment plans.

## Blended High Resolution Global Ocean Winds

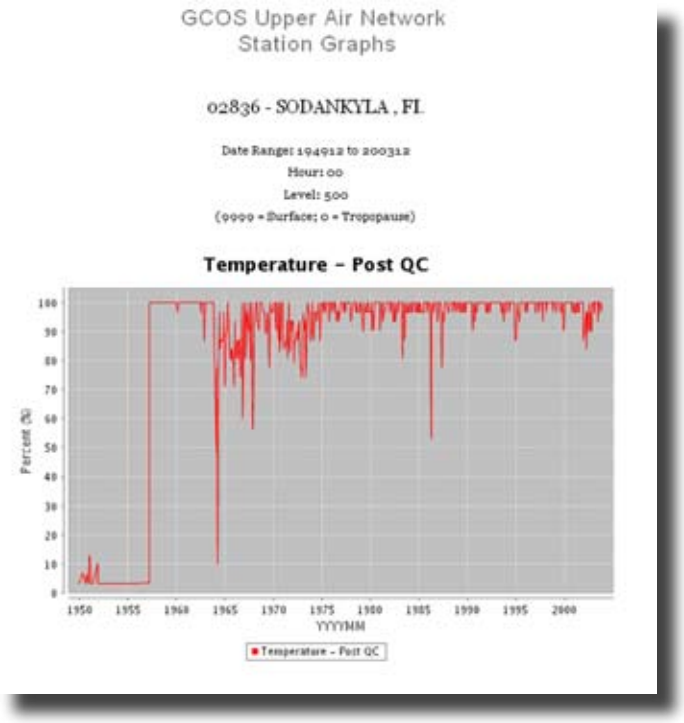
Analysis of oceanic surface winds is needed to determine air-sea fluxes of energy, water and other properties (e.g., $CO_2$). Presently, sea surface wind speeds are measured by a number of active and passive microwave satellites (more than six presently) and by in situ observations from ships and buoys. To combine these different data products, a twice-daily gridded global high resolution ocean wind analysis has been computed on a 0.25° spatial grid, from late 1987 to present. In the future, similar products at this resolution will be computed for sea surface temperature, sea surface air temperature and humidity.



# Monitoring of Observing Networks

Indicators used to summarize three different observing networks have been developed and incorporated into routine network performance monitoring. The three networks include the National Weather Service's (NWS) Cooperative Observer (Coop) Network, NOAA's U.S. Climate Reference Network (USCRN) and the Global Climate Observing System (GCOS) Upper Air Network (GUAN). Operational monitoring of all three networks is provided via measures that quantify data completeness and some measure of data quality. A web-based reporting system is maintained that allows users to specify how to summarize the performance measures. In addition, web-based Geographic Information System (GIS) mapping applications are used to facilitate access to the various reporting and graphing options and can serve as an entry point to the network monitoring system.

Since December 2003, a Coop station "watch list" has been generated for each new data month that includes stations whose monthly temperature values contain an apparent undocumented, and presumably artificial, change point. Although both documented and undocumented changes may be identified and reported, the Coop station watch list is comprised of stations with observation changes detected in the most recent 12 months that do not have a corresponding station history (metadata) record within six months of the apparent change date. Watch list reports are summarized by NWS Region and are intended to provide early warning of possible problems at a station and to ensure all planned practice changes are recorded in the metadata archives.




Example of a data completeness graph for GUAN station 02836 (Sodonkyla, Finland). The graph displays the percentage completeness of 00 UTC 500 mb temperatures that passed quality control for the period of record ending 200312

Network monitoring has been integral to the USCRN since its earliest planning stages. To ensure high standards of network performance, redundant observations of temperature and precipitation are part of each station configuration. Therefore, daily monitoring includes not only an inventory of data element receipt, but also a comparison between the various redundant measurements at each site for quality assurance purposes. All maintenance activities, routine or otherwise, are logged into the station history archives. Daily USCRN checklist and element availability reports, among others, are available via the Health of the CRN Network web page (www.ncdc.noaa.gov/oa/hofn/crn/crn-opt.html).

GUAN station data completeness is computed as the percentage of reported observations at each mandatory pressure level relative to the total number of possible sounding days in each data month. The 00 and 12 Universal Time standard reporting times are summarized separately. As a simple measure of data quality, parameter completeness percentages are calculated using both Level 1 (pre-Quality Control [QC]) and Level 2 (post-QC) values. Level 1 data is nearly raw having been subject to minimal pre-processing that includes the removal of duplicates. Level 2 data has passed through a series of quality assurance algorithms, which remove suspect values. A reduction in completeness between Level 1 and Level 2 data would be a measure of data quality.

## 2004 Achievements

In 2004 the USCRN Program was organized into broad program phases that included demonstration, continued testing and development, continued deployments, and full implementation to a commissioned network.

The USCRN has converted into an operational network that includes full documentation of the metadata, timely response to unscheduled repairs, summary and monitoring of all maintenance reports, action item notification chain and check, and QC/quality assurance (QA) of the data. The customers for the data include Bureau of Land Management, Environment Protection Agency, United States Department of Agriculture, NOAA, United States Geological Survey, National Parks Service, NOAA's RCCs, American Association of State Climatologists (AASC), and many others. The continued science component of the USCRN has established the precision and accuracy of the sensors, which has resulted in other international and national networks utilizing the same instrumentation and data processing algorithms.

On the national level, the effort to modernize NOAA's voluntary observer cooperative program is utilizing the USCRN engineering, calibration and existing test facility infrastructure. This integration is a cross-matrix activity involving NOAA's three line offices: National Environmental Satellite, Data, and Information Service (NESDIS), NWS, and Office of Oceanic and Atmospheric Research (OAR). On the international level USCRN personnel are on the National Canadian Change Management Board and a Canadian scientist is on the USCRN Ad-hoc Science Review Panel. In addition, the USCRN has co-located a USCRN station with the Canadian Reference Climatic Stations (RCS). The Canadian RCS will use a rain gauge configured identically to the USCRN rain gauge and also use the USCRN QA/QC algorithm. For temperature, the Canadian RCS will also retrofit their stations with a triple sensor configuration.


### 2004 Installations and Surveys

- Site Surveys – 126
- Sites Approved – 44
- Site Licenses Signed – 29
- Stations Installed – 24

## 2004 Sensor Testing and Science Studies

Work continued in 2004 on developing relationships between USCRN and other national and international climate networks. Due to 2004 USCRN presentations at national and international conferences, strong interest in linking or exchanging technology, observing standards, and data has been received from nations in Europe, Latin America, Asia, and Australia. Canada is the only nation, thus far, with a formal relationship with USCRN. Continued collaboration with the modernization of the NWS Coop has led to their adoption of some USCRN philosophies and technology. There is agreement to co-locate instruments. Data from co-located instruments supports and speeds temperature and precipitation transfer function development. This leverages climate-quality observations to higher-density grids from which USCRN is resource-constrained. This co-location and transfer function activity will continue indefinitely.

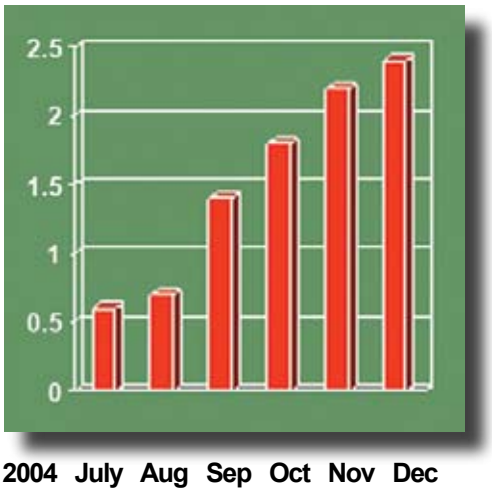
Sensor testing and science studies included refinements to existing instrumentation such as testing of all rain gauge sensing devices and the addition of a fall protection device FPD to the primary USCRN precipitation gauge. The FPD allows a valid precipitation measurement to still be made if one of the three sensors on the gauge fails. In addition, it was determined a moisture sensor would eliminate most false precipitation reports.

The USCRN temperature and relative humidity (RH) testbed is examining accuracy and reliability of RH sensors. Two years of measurements have shown that USCRN temperature sensors are interchangeable and more accurate than the standard used for comparison.

# NOMADS

## The NOAA Operational Model Archive and Distribution System

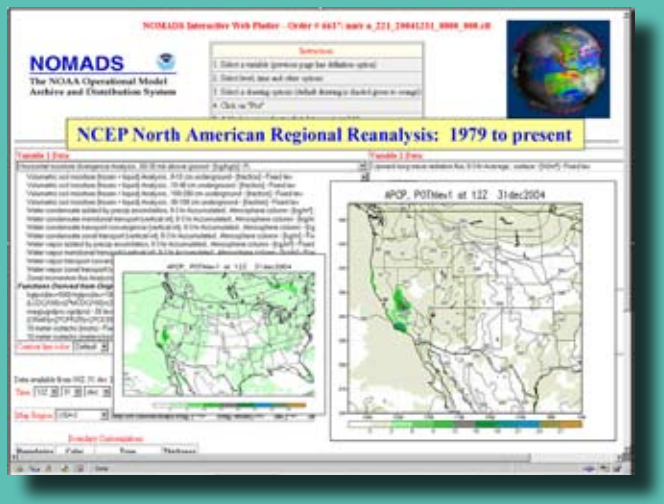
To address a growing need for distributed real-time and historical model data, the NCDC along with the National Centers for Environmental Prediction (NCEP), and the Geophysical Fluid Dynamics Laboratory initiated the NOMADS project. NOMADS is a national and international collaboration promoting open format neutral distributed access to models and data.




Historical model input and output are needed for model and observational inter-comparisons, model improvements, publications, training, and collaborations. NOMADS is filling the need for access to retrospective climate and weather models, and is the U.S. national long term model archive at NOAA's NCDC.

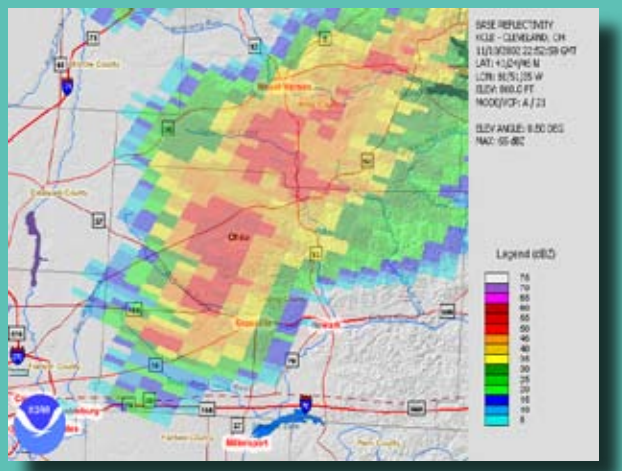
Now in its second operational year, NOMADS is experiencing extraordinary growth. In December 2004 alone NCDC NOMADS servers provided over 2 TB of model data and one million hits.

## New data sets and capabilities added during 2004 include:




- The North American Regional Reanalysis (NARR)
- A 25 year 32km reanalysis. At 4.5 TB, the NCDC NOMADS is the primary distribution point for the NARR within NOAA.
- Binary Universal Form for the Representation of meteorological data (BUFR)
- Thanks to advances developed by Center for Ocean-Land-Atmosphere Studies, the NOMADS GrADS Data Server systems can decode and serve via OPeNDAP BUFR data sets
- "Fast" ftp
- Developed by NOMADS NCEP, and modified for NCDC NOMADS, "fast ftp" uses http to dissect binary grip data on the fly and increases throughput up to 50%

## Next Generation Radar (NEXRAD)



The NEXRAD archive reached over 1000 TB (roughly equivalent to 213,000 DVDs or 1.25 million CDs) in 2004. As the archive grows, improved online inventory and access tools help customers access the data free-of-charge. New visualization software (NCDC NEXRAD Viewer) allows users to easily create high quality map images and animations. Additional software (NCDC NEXRAD Data Exporter) allows users to export NEXRAD data into common scientific formats for easy manipulation and analysis. Collaborative development with the University of Southern Mississippi, the University of Iowa, North Carolina State University and the University Corporation for Atmospheric Research (University Data – UNIDATA) will add future features and flexibility to the software packages. The software is available free-of-charge. For more information, please visit: http://www.ncdc.noaa.gov/oa/radar/radarresources.html.

## New NCDC Homepage Unveiled and Record Set for Data Delivered Online

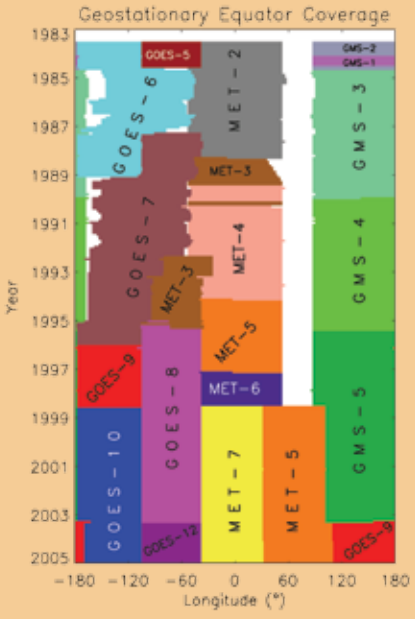

NCDC replaced its WWW homepage with a new/enhanced homepage, with easier access to online products and systems. The homepage features a new look and feel with left-side navigation, and links to various types of data (e.g., land-based) across the center of the page. This is the result of a year-long effort of the NCDC Web Committee, and includes the incorporation of input provided at the NESDIS Data User's Workshop in June 2003, and the NCDC Web Workshop in November 2003. Some of the new features include a data/products search system, which allows searching by data type (e.g., snow), location (U.S. vs. global), and time resolution (e.g., hourly): http://www.ncdc.noaa.gov/oa/mppsearch.html.

Work is continuing on the 2nd-level and lower level pages to improve consistency throughout the site and to improve overall data and information access. Also, major efforts are planned for improved metadata and GIS map server access to data and products. Partly as a result of this effort, NCDC set a new annual record during 2004, with 14.3 TB of data delivered online. This includes data from all online sources—FTP, web pages, and data access systems such as Climate Data Online, the Hierarchical Data Storage System Access System, and the various components of the Online Store. This more than doubles the total of 6.7 TB for 2003, and continues the trend toward e-commerce for NCDC. The new homepage URL is: http://www.ncdc.noaa.gov.

## Historical Publications Now Online to the Public

The NCDC has placed thousands of previously inaccessible publications online to the public. The Serial Publications web system now includes the Climatological Data, Storm Data, Monthly Climatic Data for the World, and Hourly Precipitation Data publications; for the full period of record for each publication. Thanks to CDMP efforts, publications from as far back as the late 1800s can now be easily retrieved, viewed, or printed by any user with web access. This system will continue to be expanded to include additional publications, scanned images, etc. The system URL is: http://www7.ncdc.noaa.gov/serial.publications/index.html.

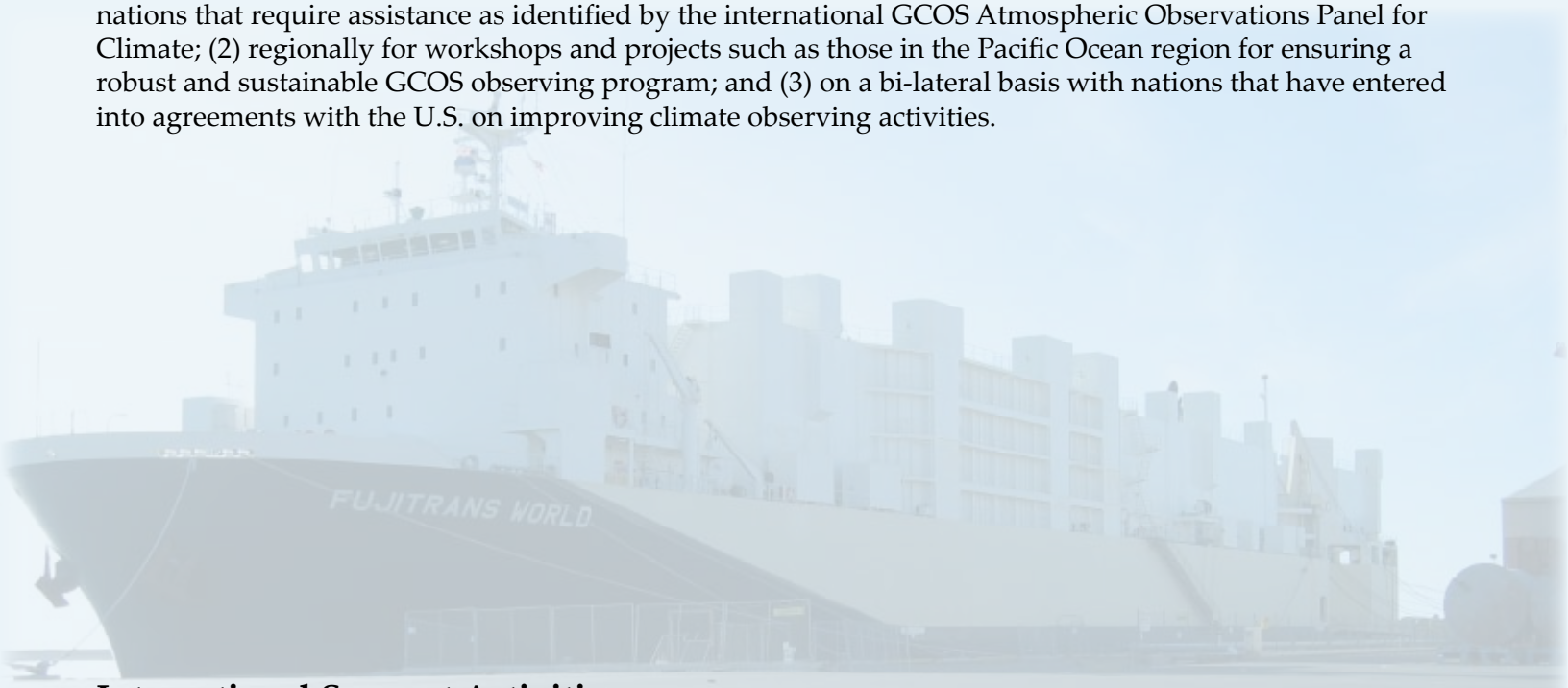
NCDC is developing a new satellite data set for climate science. Originating from the International Satellite Cloud Climatology Project; the data are observations from the Geostationary Operational Environmental Satellite (GOES) series, the European Meteorological satellite series and the Japanese Geostationary Meteorological Satellite series. The period of record covers 1983 through the present and imagery has temporal and spatial resolutions of 3-hours and 10-km. The data set will also include observations from future satellites as well, including Meteosat-8 and the Japan's upcoming MTSAT-1R. This data set consists of spectral radiances from satellite sensors and the corresponding brightness temperature or albedo for infrared and visible wavelengths, respectively. Observations at visible (0.6 μm) and infrared window (11 μm) wavelengths are available for every satellite while information at other wavelengths are included as available. Thus, this new data set will represent one of the most comprehensive satellite climate data sets available. Until now, the volume of the higher resolution B1 data was too large to be incorporated into processing. Currently, the data set is available to interested users for testing. It is hoped that through use by scientists, data set errors or deficiencies can be found and fixed before the complete data set is released to the general public later in 2005.



# Partnerships

## U.S. Global Climate Observing System (GCOS)

The U.S. GCOS Program Office is hosted by NCDC and is located at NESDIS Headquarters in Silver Spring, Maryland. The primary focus of this office is to coordinate the development of a national GCOS program that involves all U.S. Federal agencies with a role in climate observing and monitoring. As part of this effort, the U.S. national program has taken a three-tiered approach to fostering the GCOS program. This approach involves providing support: (1) Internationally to improve and enhance monitoring stations in developing nations that require assistance as identified by the international GCOS Atmospheric Observations Panel for Climate; (2) regionally for workshops and projects such as those in the Pacific Ocean region for ensuring a robust and sustainable GCOS observing program; and (3) on a bi-lateral basis with nations that have entered into agreements with the U.S. on improving climate observing activities.




## International Support Activities

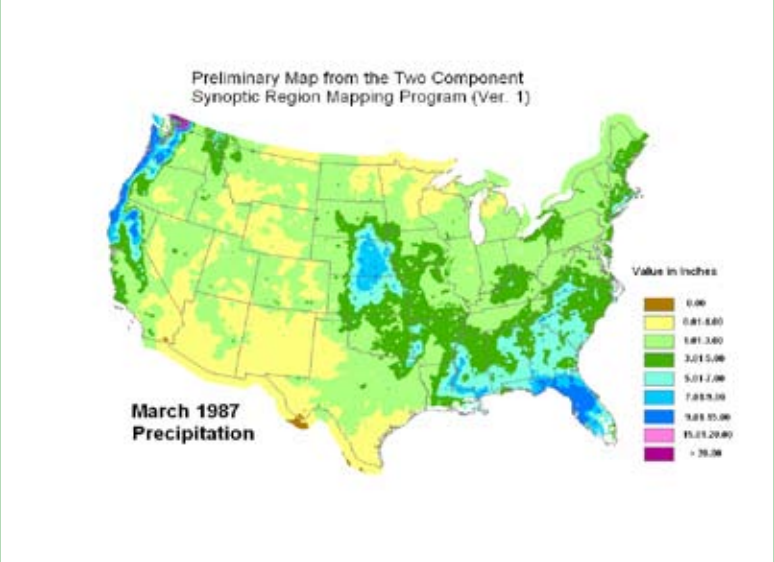
The U.S. GCOS Program Office budget for FY 2004 of $3.787M continued the work begun in 2003 and expanded support to upper air climate observing sites in Argentina, Armenia, Congo, Cook Islands, Costa Rica, Ecuador, Ivory Coast, Kenya, the Maldives, Namibia, the Philippines, and Zimbabwe. The GCOS Office's support of international observing activities was highlighted by the establishment of the first Atmospheric Brown Cloud (ABC) super site observatory in the Republic of the Madives in October 2004. This first super site will help aid the development operational network of sites in the Indo-Pacific Region in order to better study the composition and transport of the brown cloud phenomenon in that region. It is also fortunate to report that the Indian Ocean tsunami did not affect either the new observatory or the local staff. In concert with the new ABC observatory, a new GCOS Upper Air Network station was also re-commissioned in the Maldives, in that same timeframe, with support from the U.S. GCOS Program Office.

One issue that the U.S. GCOS program is addressing is the continued operation of the Global Observing System Information Center (GOSIC) located at http://gosic.org. The GOSIC has recently completed a second-phase 3-year development effort at the University of Delaware. The U.S. GCOS Office is one of the sponsors of GOSIC along with the NOAA Office of Global Programs. In 2004, a final 2-year transition grant to the GOSIC was awarded, and the intent at this point is for the GOSIC to transition its operation to a permanent operational status at NCDC. During this transition, NCDC will work with international organizations, particularly the International Oceanographic Commission's Global Ocean Observing System and the Food and Agriculture Organization's Global Terrestrial Observing System in order to ensure that the data requirements for all three GCOS domains (atmospheric, oceanic, and terrestrial) are fully met during this transition and into the new operations in Asheville.

## Climate and Weather Impacts on Society and the Environment (CWISE)

CWISE is a 4-year cooperative agreement that partners NOAA's NCDC and Coastal Services Center, with North Carolina State University, the University of South Carolina, and Clemson University. Through this program researchers from government and academia are performing studies that will help the Nation better understand and assess the impacts of climate variability and weather events on natural systems and society. Information and services will be provided which can be used to mitigate against environmental, economic, ecosystem health and human health impacts related to extreme climate conditions and atmospheric storms. The area of focus is along the South Atlantic U.S. coast, extending from the ocean to the mountain environment.

Since more than half of the population of the United States currently lives in a coastal zone, the impacts of climate variability and weather events on natural systems and society in these areas have been increasingly felt over the past several decades. To help protect the people, economy and the environment of coastal states, more accurate, timely and prognostic information concerning the impact of storms, especially as these storms relate to climate variability and change at the regional level, is needed.




In its first full year, CWISE has concentrated on five areas of focus. These involve studies concerning sea surface temperature biases and spatial climate mapping. Climatologies are also being developed for coastal areas, hurricanes and sea breezes. One of these studies is highlighted here and is showing noteworthy results.

The spatial climate mapping project will allow the automated production of high resolution climate maps to 4 km resolution. The precipitation map shown here depicts initial results from the Two Component Synoptic Region (TCSR) method. The TCSR methodology uses daily station measurements, daily Numerical Weather Prediction analyses, and high resolution topography to produce high resolution climate grids. The climate maps are constructed by averaging a series of daily maps instead of mapping a single set of point averages. This approach provides the opportunity to use information contained in weather patterns that exist for only a few days. Although the main goal is to produce long term average climate maps, the intermediate daily maps could be used for QC and climate monitoring. The two components involve a weighted average of topographic components and residual components. The topography component involves both a station's elevation and the barrier angle, which is affected by the topography and wind direction. The residual component is associated with similar topography parameters but for neighboring stations. By combining the two components, this complex weighting process is producing very promising results. When version 2 is complete in 2005, users will have visualization capabilities of climate data from their desktop for major climate parameters such as temperature and precipitation.

## NOAA's Regional Climate Center

The RCC Program was developed in response to the mandate of the National Climate Program Act of 1978 (Public Law 95-367) to improve the use and dissemination of climate information throughout the States. Since its start in 1984, the program has provided comprehensive regional decision support for climate, and today is affiliated with the NOAA's NCDC through six federated regional centers.

In 2004, the RCCs have worked diligently with NCDC to lay organizational infrastructure for:

- Climate service support
- Applied climate service for the USCRN and CDMP
- Development of a prototype quality assurance tracking system for climate data
- Deployment of a climate query system for public inquiries at NWS field offices that use NCDC data

## American Association of State Climatologists

The AASC is a professional scientific organization composed of state climatologists (one per state), directors of the six RCCs and associate members who are persons interested in the goals and activities of the Association. State Climatologists are individuals who have been identified by a state entity as the state's climatologist and who are also recognized by the Director of the NCDC as the state climatologist of a particular state.

In 2004, AASC contributed to NCDC activities through mini-grants and the State Climate Exchange Program. Projects focused on:

- Providing accurate climate station history information (Iowa)
- Developing new climate divisions (Hawaii)
- Developing spatial metadata for Cooperative Network sites (Kentucky)
- Forts data set development (Midwestern Regional Climate Center)
- Enhanced quality assurance with mesonet (Pennsylvania)
- Researching variation of peak wind speed with averaging time (Missouri)
- Developing an interface for distribution of multisensor precipitation estimates (North Carolina)
- Researching impacts of land use change on dew point temperatures (High Plains Regional Climate Center)

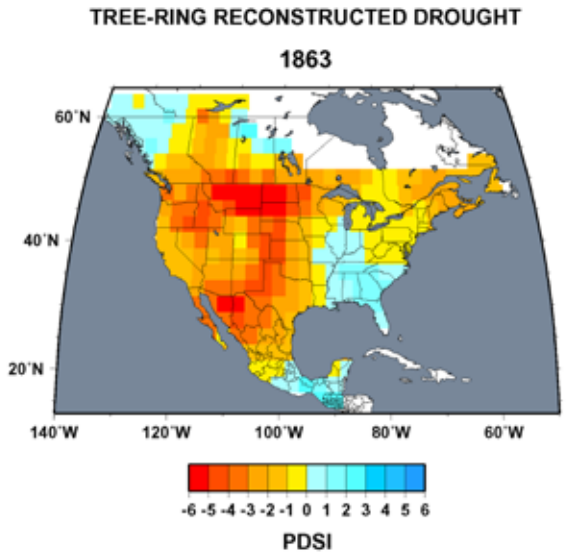
## NCDC Implements Customer Feedback

Numerous actions have been taken as a result of the customer feedback received at the 2003 NOAA Data Users' Workshop held in Boulder, Colorado. A total of 188 recommendations were received from the 375 attendees at this workshop. An Action Tracker web page was developed to follow the action plans created for the recommendations. By the close of 2004, more than 115 of the 188 recommendations had actions plans.


For reporting purposes, these recommendations were placed in the following twelve categories: Access, Archive, Data Management, Data Quality, Feedback, Formats, Metadata, New Products, New Services, Standards, Timeliness, and Web Access. A "Top 20" category was also created which represents those recommendations that were made the most often. The Action Tracker Plan can be found at http://www5.ncdc.noaa.gov/nndc/workshop/.

# Paleoclimatology

The NCDC expanded its archive of paleoclimate data, adding information from additional sites around the world. Paleoclimate data are observations of past climate and environmental variability derived from tree rings, ice cores, ocean and lake sediments, and other natural recorders, and are valuable because they help extend the instrumental record of climate farther back in time. NCDC receives contributions of published scientific data from scientists around the world, adds descriptive information, and makes these data available via the Internet. Using paleoclimate data, scientists can evaluate the natural variability of events such as forest fires and abrupt climate changes that are rare in the instrumental record.

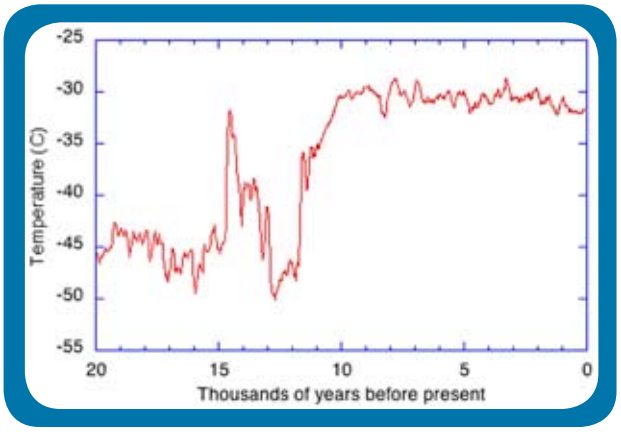



***Warm colors indicate dry conditions, and blue colors indicate wetter-than-normal conditions in this map for 1863 reconstructed from tree rings***

The topic of abrupt climate change received widespread attention in 2004, with the release of a popular movie ("The Day After Tomorrow"), and several news stories. Paleo data provide remarkable evidence of abrupt climate changes that occurred thousands of years ago. Some of these climate shifts are larger than anything observed in the instrumental record, motivating a vigorous effort to understand what causes abrupt climate change. NCDC produced a web site for non-specialists that provides an introduction to data distributed by NOAA that documents abrupt climate change.

NCDC operates an **Applied Research Center for Paleoclimatology**, with the goal to make paleoclimate data more useful to a broad audience that includes planners and decision makers. The Applied Research Center helps produce new long records of past climate and environmental variability, and improves existing records by documenting uncertainty and adding additional information. One of the most significant contributions in 2004 was a long time series of hydrologic change in the western United States, co-authored by NCDC scientists Connie Woodhouse and Mark Eakin (Cook, E. R., Woodhouse, C., Eakin, C. M., and Stahle, D. W., 2004, Long-term aridity changes in the Western United States, Science, 306:1015-1018).

NCDC also operates the **World Data Center for Paleoclimatology**, to organize and make available data contributed from scientists around the world. In 2004 the Center produced a new and expanded collection of paleoceanography data, consisting of time series derived mostly from marine sediment records of climate and ocean circulation. The expanded data collection includes over 1,400 sites contributed by several hundred investigators, who measured over 500 different proxies. "The Center also doubled the collection of observations related to fire occurence in the western United States and at sites around the world, and incorporated a new proxy of tree stand establishment with the existing tree scar and charcoal-in-sediments proxies..."




***As the Earth climate emerged from the most recent Ice age, the warming that began 15,000 years ago was interrupted by a cold period known as the Younger Dryas, which in turn ended with abrupt warming (from Paleo Perspective on Abrupt Climate Change, [www.ncdc.noaa.gov/paleo/abrupt](www.ncdc.noaa.gov/paleo/abrupt))***

# SCHOLARS

On November 17, 2004, the NCDC hosted approximately 60 students for the unveiling of their educational CD and educational packets. The NCDC signature program, SCHOLARS (Serving Customers and Helping Others Learn through Applications involving Remote Sensing) can also be viewed on the web site at www.ncdc.noaa.gov/oa/edu.html. Special commemorative CDs were presented to representatives from the following educational partners: Dr. Michael Lodico, Executive Director of Secondary Education for Asheville City Schools; Dr. Alan Lenk, Science Advisor for Buncombe County Public Schools; Ms. Elizabeth Bocklet, Asheville Buncombe Education Coalition; and Mr. Robin Myer, Executive Director of Big Brothers/ Big Sisters of Western North Carolina. The students toured the museum, listened to presentations on both GOES and Polar-orbiting Operational Environmental Satellites and experienced the Magic Planet. The event was supported by Robert Carey, Office of Research and Applications and Tom Wrebleski, Office of Satellite Development. Assistance was also provided by Dr. Max Lennon of the Education and Research Consortium. Dr. Colleen Hartman, Deputy Assistant Administrator for NESDIS, presented an overview of NOAA education initiatives and provided positive feedback on the program.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## ACRONYMS

**AASC**
American Association of State Climatologists

**ABC**
Atmospheric Brown Cloud

**BUFR**
Binary Universal Form for the Representation of meteorological data

**CDMP**
Climate Database Modernization Program

**CDR**
Climatic Data Record

**CLASS**
Comprehensive Large-Array data Stewardship System

**CooP**
Cooperative Observer Network

**CWISE**
Climate and Weather Impacts on Society and the Environment

**FPD**
Fall Protection Device

**GCOS**
Global Climate Observing System

**GIS**
Geographic Information System

**GOES**
Geostationary Operational Environmental Satellite

**GOSIC**
Global Observing System Information Center

**GUAN**
GCOS Upper Air Network

**NARR**
North American Regional Reanalysis

**NCDC**
National Climatic Data Center

**NCEP**
National Centers for Environmental Prediction

**NeS**
NESDIS e-government System

**NESDIS**
National Environmental Satellite, Data, and Information Service

**NEXRAD**
Next Generation Radar

**NGDC**
National Geophysical Data Center

**NODC**
National Oceanographic Data Center

**NOMADS**
NOAA Operational Model Archive and Distribution System

**NVDS**
National Virtual Data System

**NWS**
National Weather Service

**OPeNDAP**
Open-source Project for a Network Data Access Protocol

**QA**
Quality Assurance

**QC**
Quality Control

**RCC**
Regional Climate Center

**RH**
Relative Humidity

**SCHOLARS**
Serving Customers and Helping Others Learn through Applications involving Remote Sensing

**SDS**
Scientific Data Stewardship

**TB**
Terabyte

**TCSR**
Two Component Synoptic Region

**USCRN**
U.S. Climate Reference Network

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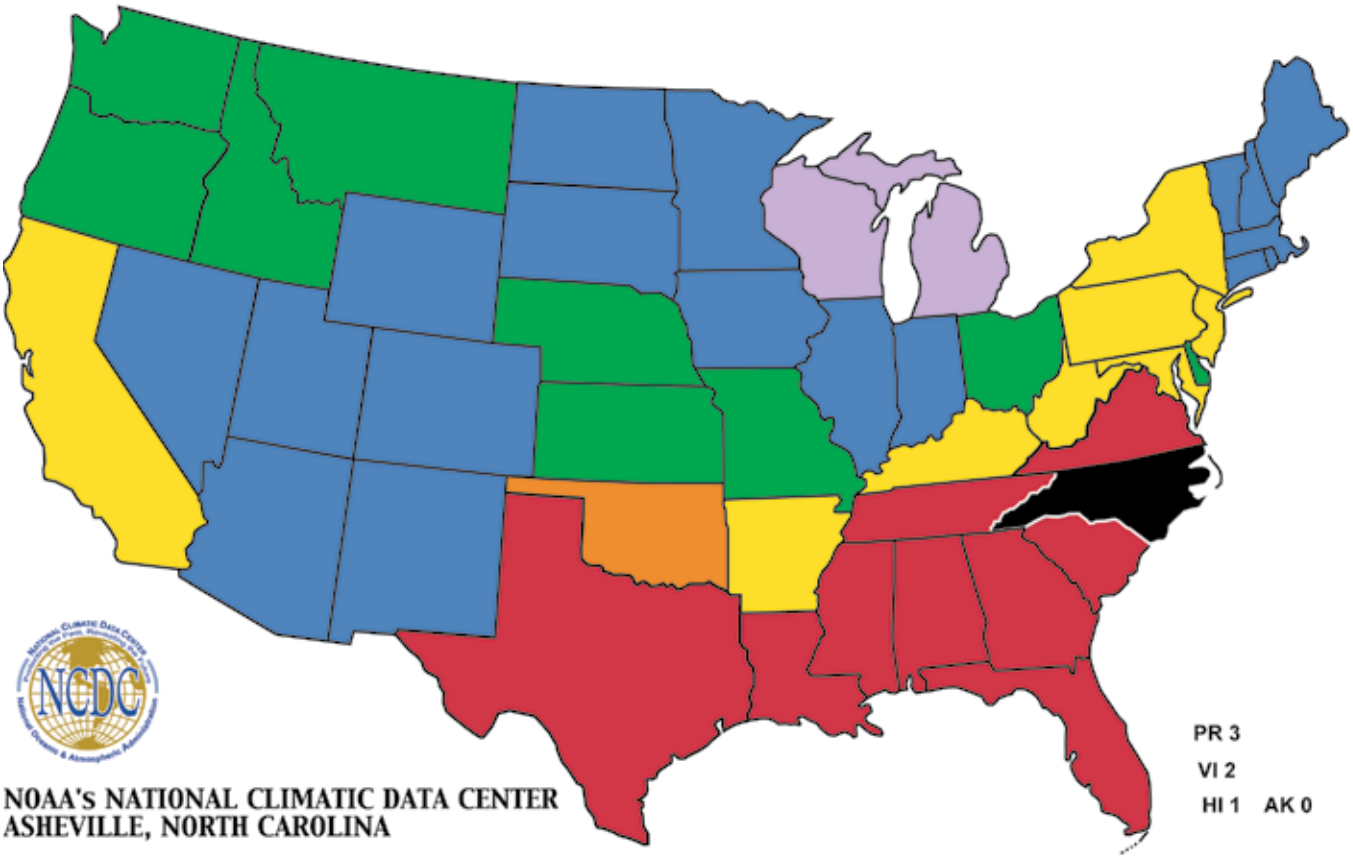
# BILLION DOLLAR CLIMATE AND WEATHER DISASTERS 1980 - 2004




NOAA'S NATIONAL CLIMATIC DATA CENTER
ASHEVILLE, NORTH CAROLINA

| NUMBER OF EVENTS |
|---|
| 21 - 25 |
| 16 - 20 |
| 13 - 15 |
| 10 - 12 |
| 7 - 9 |
| 4 - 6 |
| 1 - 3 |

| DISASTER TYPE | NUMBER OF EVENTS | PERCENT FREQUENCY | NORMALIZED DAMAGES (Billions of Dollars) | PERCENT DAMAGE |
|---|---|---|---|---|
| Tropical Storms/Hurricanes | 20 | 32.3% | 144 | 36.8% |
| Non-Tropical Floods | 12 | 19.4% | 55 | 14.1% |
| Heatwaves/Droughts | 10 | 16.2% | 144 | 36.8% |
| Severe Weather | 7 | 11.3% | 13 | 3.3% |
| Fires | 6 | 9.6% | 13 | 3.3% |
| Freezes | 2 | 3.2% | 6 | 1.6% |
| Blizzards | 2 | 3.2% | 9 | 2.3% |
| Ice Storms | 2 | 3.2% | 5 | 1.3% |
| Noreaster | 1 | 1.6% | 2 | 0.5% |
| | 62 | | 391 | |

Please note that the national map color-coded by state reflects a summation of billion dollar events, for each state affected--ie, it does not mean that each state shown suffered at least $1 billion in losses for each event.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